REMOTE SENSING CENTRE

PEATLAND INVENTORY OF MANITOBA

I—THE PAS

Using LANDSAT

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Manitoba
Natural Resources
Surveys and Mapping

October, 1984

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ABSTRACT

The province of Manitoba has extensive peatlands which could be of potential value for agriculture, forestry, the fuel industry and horticulture. Information is required on the type, extent, and quality of peatlands before this value can be realized.

The Manitoba Department of Energy and Mines sponsored this study as part of their mandate, to define the abundance and extent of various commercial peatlands. The purpose was to determine if a "quick look" inventory of the provinces peat resources could be undertaken using Landsat data.

The study area was located in the west central part of Manitoba between latitudes 53 and 54 degrees north and between longitudes 100 and 102 degrees west.

An interactive digital image analysis system, called the Applied Resources Image Exploitation System (ARIES-II, Dipix Ltd.) was used to process Landsat multispectral data. A supervised classification technique classified one computer compatible tape, Path 37, Row 22 from June 26, 1981.

The results of the classification were compared to reference data which included soil maps, panchromatic aerial photography and field information. Hard-copy output information was in the form of a colour-coded thematic map. The overall accuracy for all classes on the thematic map was 82 percent. The

classification success for the peat containing classes were: Treed bog (80%) shrub-treed fen (78%) and graminoid-rich treed fen (71%).

Satellite remote sensing of peatland vegetation, combining manual and machine interpretation of data, provides a valid estimate of areal extent.

ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

1.1 Background

Peatlands have a high potential for multiple-use applications in agriculture, forestry, horticulture, fuel, industry, conservation and recreation (IPS Proceedings I-VII, 1954-1984). Manitoba has extensive peat deposits which are estimated at 30% of the provincial land base (Smith, 1978). Of this impressive figure, only a small portion may prove to be economically exploitable. Many Manitoban bogs and fens are too inaccessible at any price. Other peatlands are included in federal and provincial park areas and remain unexploitable. Also much of our organic terrain contains shallow, poor quality peat not worth commercial exploitation.

Horticultural peat moss and its by-products are the most important use of peat in the province, which in 1984 is expected to be worth approximately $13 million. Almost 100 farms are working on either shallow or reclaimed peat areas, mostly in the marginal lands bordering the eastern Red River valley (Manitoba Farming Association Annual Report, 1983). While not of immediate importance to Manitoba, peat is being investigated actively in neighbouring Ontario (Monenco, 1980) and Minnesota (Mundale, 1981) as an alternate energy resource.

1.2 Resource Issue

Peatlands are often barriers to the development of energy, mining, forestry and transportation needs of northern Manitoba. Since peatland development involves either the extraction and drainage of peat in surface mining operations or removal of the surface vegetation and drainage in crop farming operations, then conflicts will arise over the environmental, social and economic impacts associated with such a natural resource development. Hence useful information on the type, extent and quality of our peatlands are essential before the management of a resource like peat is undertaken on any scale in Manitoba.

Methods for the mapping of peatland inventories, such as the use of large scale panchromatic, colour and colour IR aerial photographic studies, are feasible though expensive. Dixon (1981) demonstrated the mappability of wetland types in vegetation mapping of caribou winter range in northern Manitoba using Landsat imagery and Pokrant and Wilson (1984), used Landsat computer classification to aid in the multi-terrain selection of potential Parklands in Manitoba. Singhroy and Bruce (1983) reported on the successful application of enhanced Landsat data for the relatively inexpensive inventory, classification and mapping of the major wetland environments in Manitoba.

The Manitoba Department of Energy and Mines sponsored this study in order to establish the abundance and extent of various bogs and fens considered to be of commercial significance. The Manitoba Remote Sensing Centre (MRSC) undertook this project in

response to an identified need for a preliminary demonstration to derive a peatland theme classification, which could lead eventually to a 'quick-look' inventory of the province's peat resources. Should LANDSAT imagery analysis of a demonstration area prove reliable, then an inventory of commercially viable peat deposits would be possible within the province. Because the classification and inventory of Manitoba's peatlands is an ambitious undertaking, it was decided to focus on a known area of peatland to characterize the training areas and subsequent extrapolation of surface relationships.

1.3 Objectives

The goals of this project are:

1. To establish a reliable interpretation of Landsat imagery in a demonstration project area (The Pas, 63F NTS map series) chosen for its extensive peatlands and reasonable accessibility for ground-checking. Many representative types of Manitoba's peatlands are found within this map sheet.

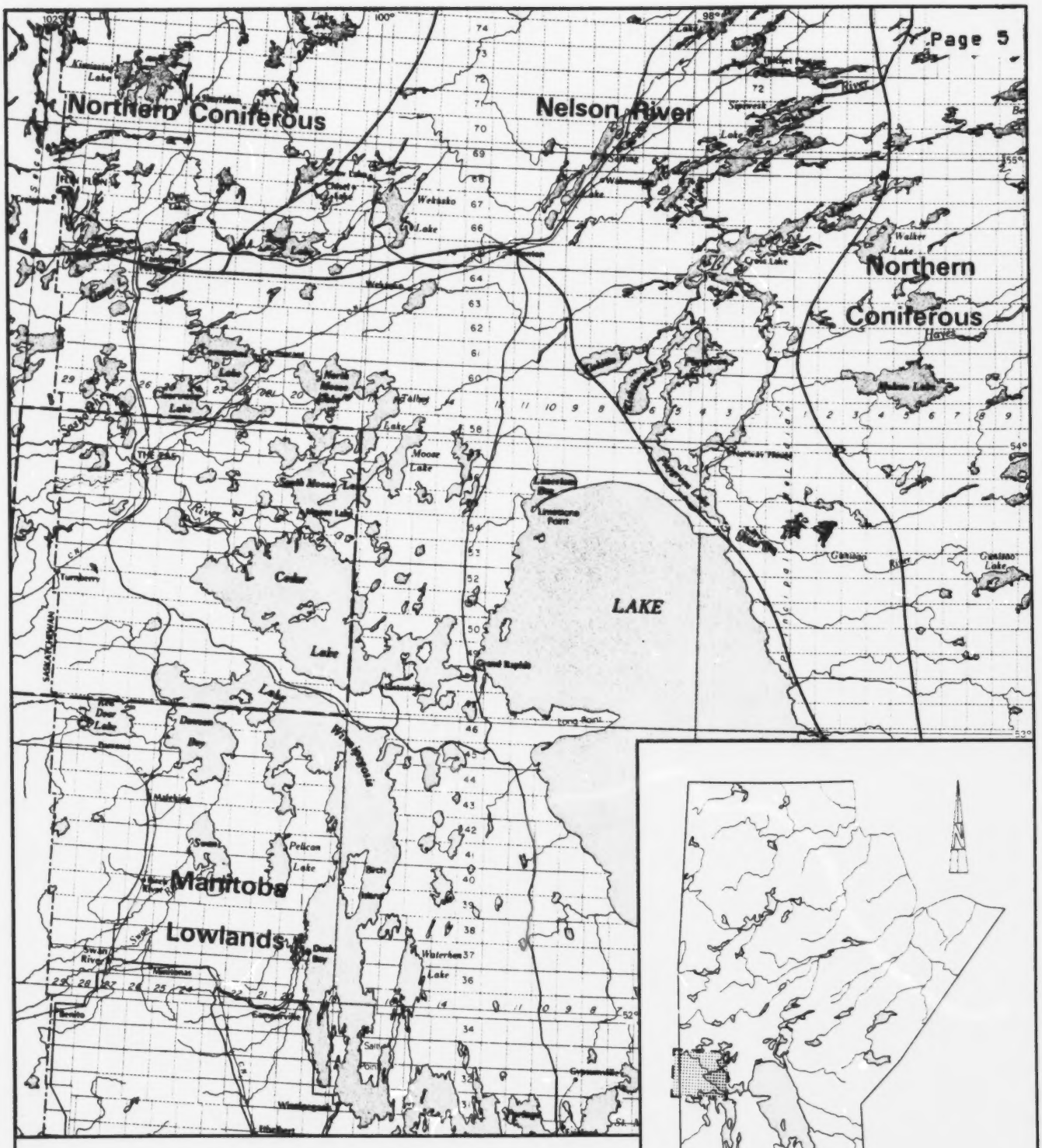
2. To produce a vegetation cover map for approximately 12,500 square kilometers of The Pas map sheet at a scale of 1:250,000 using Landsat imagery. Additionally the distribution and type of peatlands (bogs, fens and marsh) in the region were assessed using aerial photography (1:15,840) and field data.

3. To evaluate the level of classification accuracy and methodology for the additional mapping of peatlands in the province.

2.0 STUDY AREA

2.1 Location

The peatlands involved in this study are located in the west central part of Manitoba between latitudes 53 degrees and 54 degrees N and between longitudes 100 and 102 W. The position of the study area with respect to the rest of Manitoba is shown in Figure 1. The Pas map sheet (NTS 63F Townships 47-58, Ranges 18-31) covers approximately 12,500 sq. km. of which some 4,000 sq. km. are water. Approximately ninety percent of the study area is in Manitoba and the remainder is in Saskatchewan.



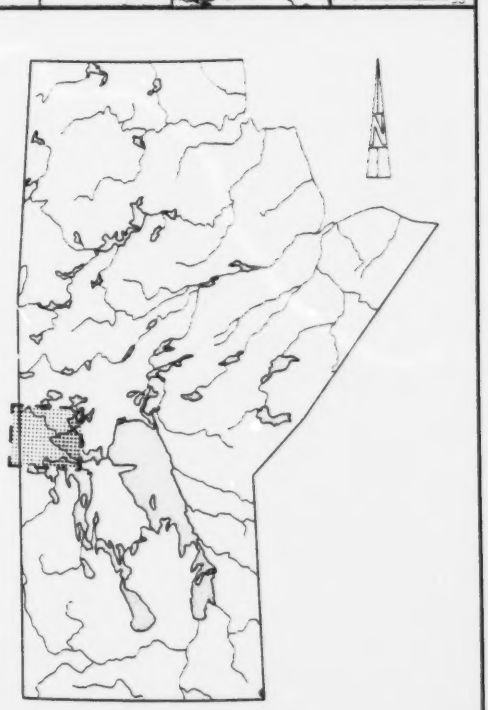
FOREST SECTIONS OF THE BOREAL FOREST

STUDY AREA — — — —

Scale 1:2 000 000

Source : Rowe 1972

Figure 1



Key Map

2.2 Climate

The Pas airport has the only recording meteorological station in the map area. The region is classified as Low Boreal climatic subregion with a growing season varying between 165 to 167 days and an average frost free period of 104 days (Hopkins and Smith, 1982). Mean daily temperatures during summer range from 9-18 degrees Celsius and the mean total precipitation is around 490 mm (Environment, Canada). Peatlands occupy much of the Low Boreal climatic subregion.

2.3 Vegetation

Rowe (1972) classified The Pas map sheet as within the northern sector of the Boreal Forest region in the Manitoba Lowland Section (B15). Much of the area is characterized by mixed coniferious-deciduous forest vegetation underlain by a variety of soils consisting mainly of Luvisols, Brunisols, Gleysols and organic soils. Bogs and fens occur extensively throughout the map sheet.

Bog vegetation consists mostly of stunted black spruce (Picea mariana), tamarack (Larix laricina), leatherleaf Chamaedaphne calyculata), and Sphagnum mosses. The ericoid shrub layer is dominated by baked apple-berry (Rubus chamaemorus) leatherleaf and labrador tea (Ledum groenlandicum). Herbs, forbs

and non-vascular plants include sedges, (Carex spp. Scirpus spp.) bog cotton (Eriophorum spp.), horsetails (Equisetum spp.) bog mosses and lichens.

Fens are wetlands which occur over a range of successional gradients from graminoid fen to shrub fen to graminoid treed fen (Jeglum et al 1974). Because of these gradients, difficulties were encountered by Sims et al, (1981) in classifying fens into adjacent classes. The principal vegetation is tamarack, either scattered or in clumps, associated with ericoids, and non-sphagnic mosses. Open water on the surface is often visible throughout the year. The better drained mineral sites are characterized by stands of white spruce (Picea glauca), jack pine (Pinus banksiana), aspen (Populus tremuloides) and white birch (Betula papurifera). The distribution of such species is often a reflection of seral responses to fire or other disturbances. Along The Pas moraine between Cedar Lake and Lake Winnipegosis are stands of eastern white cedar (Thuja occidentales), mountain ash (Sorbus americana) and mountain maple (Acer spicatum).

The ecotonal areas between the better and poorer drained areas including the Saskatchewan Delta, are occupied by a more diverse tree and shrub flora; for example, aspen, balsam poplar (Populus balsamifera), elm (Ulmus americana) green ash (Fraxinus pennsulvanica), Manitoba maple (Acer negunda) and balsam fir (Abies balsamea) are most noticeable. On the wetter sites, sedges (Carex and Scirpus spp.), reed grass (Phragmites australis) and cattails (Typha spp.) dominate the surface cover. Willows (Salix spp.) and swamp birch (Betula pumila) are

scattered throughout with local concentrations on the edges between community-types.

3.0 METHODS

3.1 Cover Type Classification

Most wetland classifications in Canada are defined in physiognomic and floristic terms (Jeglum et al, 1974; Tarnacoi, 1978; Zoltai and Pollett, 1983). These classification systems are based upon diagnostic features visible in both field situations and aerial photographs; and include most of the known wetland types found in Canada at several hierarchical levels. Such classifications are open to improvements and expansion as information and experience increases.

The wetland classification for this project comprises two levels only:

1. The Wetland Class which reflects groupings of wetlands produced from specific biotic communities and observed conditions. Broad vegetation groupings are the basis for separating the wetland classes.

2. The subclass level of generalization is based upon primarily the visible hydrologic properties of the class units.

The cover type classification developed for this project is a modification of the Jeglum et al, (1974), and Zoltai and Pollett, (1983) wetland classification. Three major types of

wetland environments were recognized for mapping purposes, namely bogs, fens and marshes. Eleven different themes were mapped of which five were wetland types of three classes (bog, fen and marsh) and two subclasses (fen and marsh).

The following is a description of the mapping units used in this project:

3.1.1 Treed Bog -

The bog class is characterized by a peat substrate, often Sphagnum-rich, and ranging in depths up to 7.5 m though most of the ground-check sites were <3 m. The open bog category is rare in this area; low density treed bog is the most common vegetation grouping. Bogs have localized pools of standing water on the surface in Spring. The major source of moisture is precipitation with minor input from surface or ground-water flow in lag areas. Vegetation is dominated by stunted black spruce. ericaceous shrubs and Sphagnum mosses,

3.1.2 Shrub-Rich Treed Fen -

Fens are often located in open drainage systems eg. margins of lakes and streams. They are peat-filled depressions characterized by the water table reaching the surface during Spring but with little standing water during the Summer. The vegetation is characterized by low shrubs (<135 cm) interpersed with sedges, grasses, and scattered tamarack and black spruce. The principal shrubs are swamp birch, leatherleaf, sweet gale

(Myrica gale), and meadowsweet (Spirea alba). The topography is slightly hummocky. The substrate consists mostly of mesotrophic peat ranging from 30 cm to 2.5 m in depth.

3.1.3 Graminoid-Rich Treed Fen -

Such fens have open graminoid areas interspersed with islands of stunted trees. Strings and flarks are present in specific locations and are characterized by mature trees and shrubs. Standing water on the surface is often evident throughout the growing season. Vegetation consists primarily of mosses, e.g. Scorpidium scorpides, Tomenthypnum spp., sedges, e.g. Carex flava, C. lasiocarpa, Scirpus hudsonianus and Rhynchospora spp., shrubs, e.g. swamp birch, and Labrador tea and trees e.g. tamarack and black spruce. Topography is mostly hummocks interspersed with pools of standing water. The nutrient status ranges from eutrophic to minerotrophic.

3.1.4 Marshes -

Marshes are subdivided on the basis of perceived water depth and geomorphological status. The vegetation is characterized by closed graminoid and sedge canopies interspersed with willow and alder islands. Continuous ribbons of deciduous trees and woody shrubs are found along river channels. Index species are Reed grass and Scirpus spp. The substrate ranges from thin organic/mineral alluvial to well humified peats of relatively shallow depths. The topography is basically flat with occasional elevated areas colonized by shrubs.

3.1.5 Saskatchewan River Delta -

This area is the graminoid/shrub marsh colonizing much of the Saskatchewan river delta. Because of its unique position and the temporary nature of the substrate for mapping purposes, it was given a separate theme status.

3.1.6 Coniferous Woods -

Black spruce is the most common tree found growing over many of the poorer-drained sites. Stands of jack pine dominate better-drained sites with white spruce and balsam fir co-dominant in localized areas along river banks and low ridges.

3.1.7 Mixed Woods -

In many areas, usually old fire or log-cutting areas, mixed stands of trembling aspen and white birch are scattered between or mixed with jack pine, white and black spruce, and balsam fir. Such areas are extensive and often on the edge of the coniferous or deciduous themes.

3.1.8 Deciduous Woods -

This class comprises the largest of the non-wetland themes. Extensive fires of recent origin and forest cutting have resulted in the regeneration of the early successional stages of the principal forest cover. The dominant vegetation are poplars (Populus tremuloides, P. balsamifera), birches, willow, and alder (Alnus spp.).

3.1.9 Agriculture -

This cover type contains all past and present cultivated areas. Bush, meadow and croplands have different reflectances according to soil capability and management. Most of this theme is confined to the Pasqui development located to the west of The Pas. Some cultivated land is found immediately to the east and the north of the town of the The Pas.

3.1.10 Water -

This category includes all lakes, rivers and ponds of open water with areas greater than 1/4 hectare.

3.1.11 Cultural -

This final theme covers all man-made structures and includes the town of The Pas, roads and airport clearances.

3.2 Data Acquisition

Landsat microfiche files at the Manitoba Remote Sensing Centre (MRSC) were examined to determine the availability of multispectral scanner (MSS) images for the study area. Selection was based on cloud free conditions, during the period of late June to early August. The following Landsat II image was ordered as digital data on a standard computer compatible tape (CCT) from Path 37, Row 22.

Image Date	ID Number
81-06-26	22347-17003

Reference data consisted of aerial photographs, National Topographic Series (NTS) maps and Soil Survey maps.

Panchromatic aerial photography dated 1981-82 provided coverage for the entire study area. The photography was flown during the summer at a scale of 1:15,840 for Forest Inventory purposes. Soil survey and NTS maps provided reference information for the selection of sub-areas and geometric correction of the satellite data.

3.3 Data Analysis

Computer analysis of the satellite data was achieved with the Applied Resource Image Exploitation System (ARIES-II) image analysis system. Image Analysis operations were conducted in three stages (Figure 2). Stage one consisted of image preprocessing and included geometric corrections image to grid. Stage two resulted in the classification of the satellite data. The third stage consisted of post classification filtering, manual theme assignments and the generation of output products.

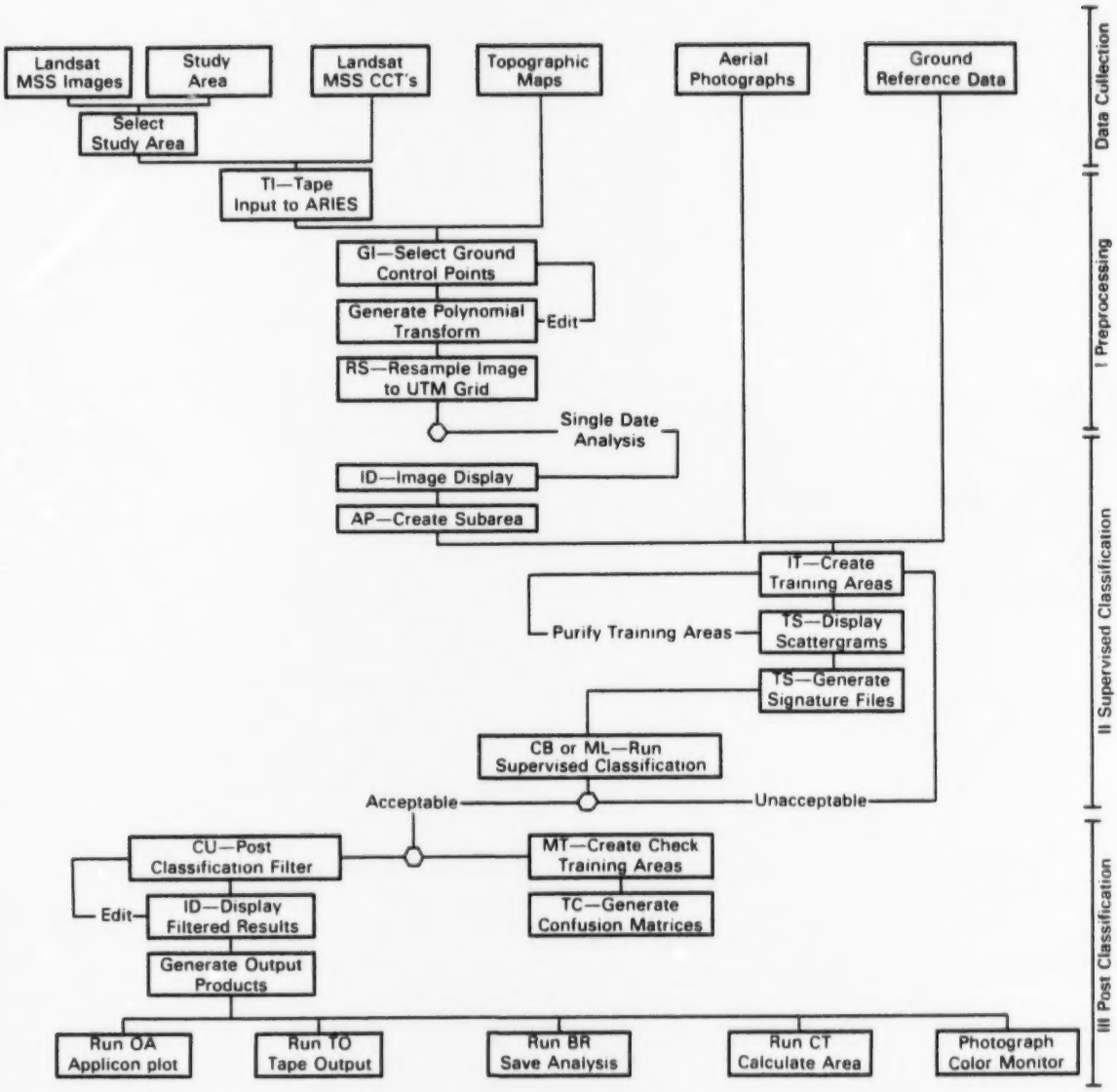


FIGURE 2: Flow chart of image analysis procedures followed on the ARIES—II image analysis system. Programs indicated by the two character identifiers are for version 2.1 of the All ASP software package.

3.3.1 Image Preprocessing -

Image preprocessing consisted of image to Universal Transverse Mercator (UTM) grid registration. The first step in the image to grid registration was to generate a series of 15 ground control points (GCP's). GCP's are points that were identified by their line/pixel coordinates on the satellite image and linked to corresponding northing/easting coordinates on the UTM grid system. The image transformation (change in image geometry) was achieved by a second order polynomial transformation.

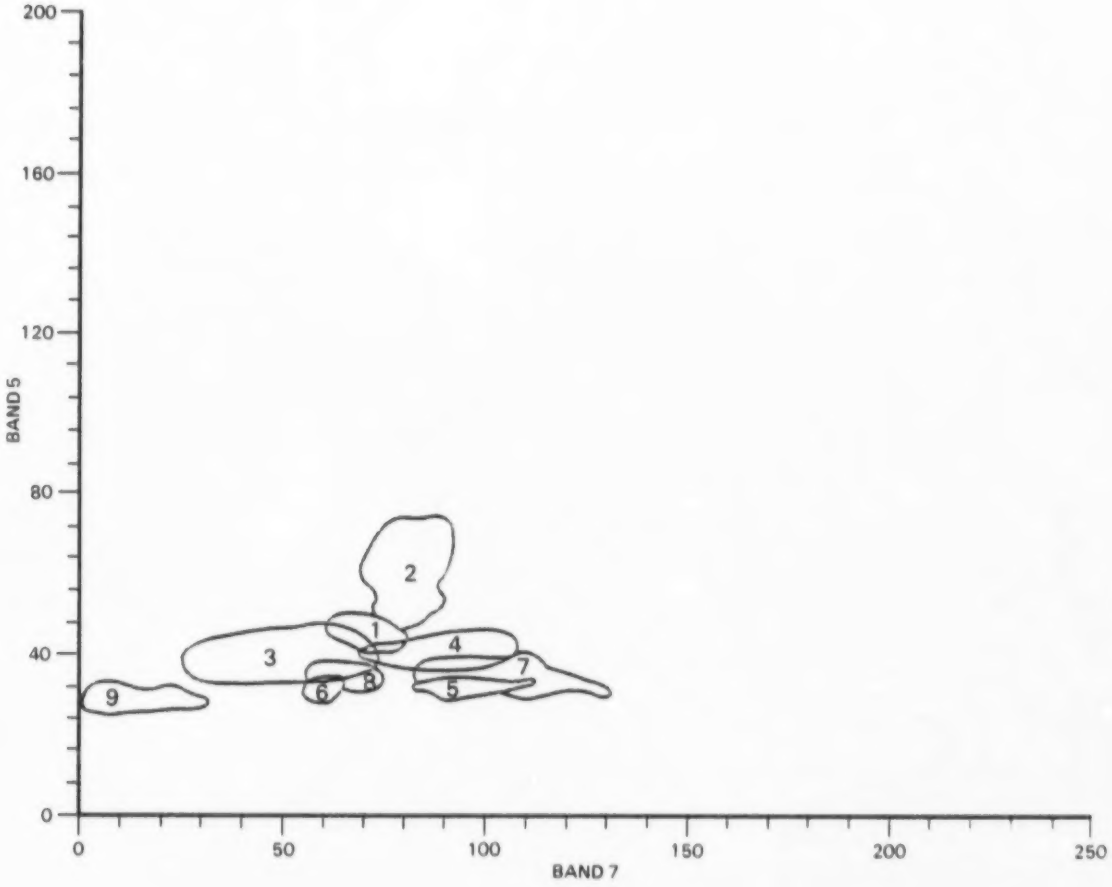
The second step in the image to grid registration process was to generate a new image file by resampling an input file according to the parameters in the polynomial transform. The cubic convolution algorithm was used to resample each MSS band. In resampling from image to grid the standard 79 m x 59 m pixels were resampled to 50 m x 50 m.

3.3.2 Image Classification -

Image classification involved a supervised method. Reference data, which included both ground and airphoto information were used to "train" the computer to recognize cover types of interest.

Training areas (T.A.'s) are groups of pixels known to represent the spectral characteristics of a known cover type. All training areas that corresponded to one cover type formed a cluster. Each cluster represented a specific location in feature space and could be identified by their spectral coordinates.

Scattergrams, which are a 2-dimensional representation of spectral coordinates, were used to display cluster data in Bands 5 (Y- axis) and 7 (X-axis) (Figure 3). During the training scattergrams were continually examined to ensure sufficient separability between clusters.



(1) Shrub-Treed fen
(2) Marsh
(3) Gramminoid-rich fen
(4) Treed Bog
(5) Mixedwood
(6) Jack Pine
(7) Deciduous
(8) Conifers
(9) Water

FIGURE 3: Band 5 vs Band 7 scattergram showing reflectance values for each land cover category.

When the training process was completed, theme statistics were computed. A maximum likelihood signature file was generated using the training area data. The signature file provided the statistical parameters that described the spectral characterization of each cover type.

A maximum likelihood classifier (Shlien and Goodenough 1973) was then applied to the signature file. The classification results were stored in theme files which were displayed on the colour T.V. monitor for a visual assessment. Aerial photographs and soil survey data (Hopkins and Smith, 1982) were used to assess the thematic data. Five areas of the thematic data were checked in a non-decimated form for classification errors. If the results were considered unacceptable further modifications to the training areas were conducted.

3.3.3 Post Image Classification Analysis -

Post image classification analysis included application of a minimum area filter, manual theme generation and accuracy assessment. A minimum area filter was applied to the final classification to remove "noise" from the thematic data by replacing small areas with larger surrounding areas. The minimum size areas selected for the filter were based on visual comparison between classification results and ground reference data.

The results of the filtered image were compared with check training areas. Each check training area represented a known cover type and was assigned to a separate theme file, but the same theme bit position as the original classification.

A theme compare program was used to compare manually generated themes derived from check T.A.'s with the classifier themes. The result was a confusion matrix which provided an indication of cover type classification accuracy and where confusion between cover types existed.

The manual theme program was also used to correct known areas of misclassification, as detected with reference data.

When satisfactory classification results were obtained, colour-coded thematic maps were produced.

4.0 RESULTS

4.1 Preprocessing

Geometric correction of CCT's on the ARIES-II was an efficient and accurate means of obtaining resampled data. Extensive batch processing time was required with complete access to the video display subsystem. On average, 4.0 hours per band were required to resample 50 m x 79 m pixels to 50 m x 50 m pixels. Six hours were also required to select GCP's, with a total computer time needed to correct the image of 22.0 hours. The accuracy of the geometric correction depended on the care taken in selecting GCP's and the order of polynomial transform applied (Shlien 1979). Selection of 15 GCP's and a second order transformation resulted in a mean standard error in the pixel direction of 0.82 and in the line direction of 0.66, which is less than a pixel in either direction across the image.

4.2 Image Classification

One colour-coded thematic map was produced for the study area, at a scale of 1:250,000. Colour themes represented wetland classes, upland classes and a water class.

A confusion matrix was used to assess accuracy of the classification results (Table 1). The matrix compared pixels of check training areas with the same pixels from the classification.

Classified Theme Files

Manual Theme File

	Treed Bog	Shrub Treed Fen	Gram-Rich Fen	Marsh	Mixed Wood	Jack Pine	Deci.	Coni.	Water	Total	%
Treed Bog	18,864	2966	4	25	4	0	690	851	0	23,404	80
Shrub Treed Fen	1	1287	116	231	0	0	0	0	0	1,635	78
Gram-Rich Fen	0	468	1205	1	0	0	0	1	0	1,675	71
Marsh	31	154	45	8189	0	0	15	0	1	8,435	97
Mixed Wood	65	0	0	0	2210	18	1526	92	0	3,911	56
Jack Pine	0	0	0	0	11	105	51	346	0	513	20
Deci.	44	0	0	0	2107	2	4509	78	0	6,740	66
Coni.	80	21	446	0	0	250	12	2337	0	3,146	74
Water	5	14	2097	2	0	0	33	6	23,112	25,269	91

Table 1: Confusion matrix of manually classified pixels verus pixels in the classified theme files

5.0 DISCUSSION

Values off the diagonal indicated a classification error. The matrix did not provide percentages for errors of omission; however, they can be calculated. The theme compare method was a quick way of assessing accuracy and helped to determine if there was a problem originating in the initial training area data. In some instances it was difficult to locate sets of pixels with absolute certainty that provided distinctive spectral signatures for the classes required. Obvious errors in classification were detected by this method (Kalensky 1974).

In the treed-bog theme 80 percent of 23,404 pixels examined were correctly classified. The major confusion occurred with shrub-treed fen which consisted of 2,966 or 13 percent of the remaining pixels.

In the shrub-treed fen theme 78 percent of the 1635 pixels sampled were correctly classified. Confusion occurred with marsh where there is similarities in vegetation cover types.

The Graminoid-rich treed fen theme had 1,205 or 71 percent of 1,675 pixels classified correctly. Of the 470 pixels incorrectly classified 468 or 28 percent were classified as shrub-treed fens.

Of 8,435 pixels selected within the marsh theme, 8,189 pixels or 97% were correctly classified. The highest number of incorrectly classified pixels were found in the shrub-treed fen category.

The mixedwood theme had 56 percent of 3,911 pixels classified correctly. The majority of the confusion occurred with the deciduous theme which consisted of 39 percent of the remaining pixels.

In the jack-pine theme 513 pixels were sampled, with only 20 percent accuracy. The majority of the confusion occurred with conifers where 346 or 67 percent of the pixels were found off the diagonal. Both these themes had similar spectral signatures (figure 3).

The deciduous theme had 6,740 pixels sampled with a 66 percent accuracy. The majority of the confusion occurred with the mixedwood theme which consisted of 31 percent or 2,107 pixels.

In the coniferous theme 74 percent of 3,146 pixels sampled were classified correctly. Of the 809 pixels that did not fall on the diagnonal, 446 (14%) were classified as graminoid-rich treed fen and 250 pixels (8%) were classified as jack pine. The graminoid-rich treed fen pattern fen had a very dark signature due to standing water, therefore the confusion.

In the water theme 91 percent of 25,269 pixels sampled were classified correctly. Of the 2,157 pixels incorrectly classified 2,097 or 8 percent were classified as graminoid-rich treed fen.

In summary 74,728 pixels were checked and 61,818 or 82 percent were correctly classified. A significant portion of the classification error can be attributed to attempting the separation of jack pine from other conifers. Also, the separation of mixedwoods (deciduous-coniferous) and deciduous cover decreased overall accuracy. The accuracy of these classes did not have a significant bearing on the objectives of the study, however, because the jack pine accuracy was so small it was combined with the conifers, whereas the deciduous and mixedwoods were not changed.

On the final map a decision was made to combine shrub-treed fen and graminoid-rich treed fen. The vegetation cover was similar in both classes.

Agricultural land, delta marsh and cultural features (i.e. roads) were all misclassified in a preliminary classification. During the post-classification process a "manual theme" task was used by the image analyst to correct this error. This task affords direct control by the analyst over the contents of a theme. New theme files were therefore created for the three misclassified themes.

The southwest corner of the study area was unclassified because the Landsat raw data used had not been corrected far enough south.

Increasing awareness of the value of peat and peatlands for commercial purposes have emphasized the need to develop remote sensing techniques for resource survey and evaluation. Current demands for information on the extent and location of commercial peat deposits in Manitoba created an opportunity for testing a multi-level sampling strategy, which related medium scale aerial photography of selected sites to MSS satellite imagery and, in this project, limited ground truth data.

The accuracy of the categories derived from the supervised classification of Landsat data was assessed by comparing the classified areas against the actual ground areas for the selected test sites from aerial photographs (1:15,840). The results of these checks indicated that the Landsat classified categories and the corresponding photographic categories were highly correlated for the wetland classes of interest to this study. Thus the gradient for the peat- containing classes was Treed bog (0.80) > Shrub treed fen (0.78) > Graminoid-rich treed fen (0.71). The range in correlation exhibited by the remaining 8 themes was 0.97 - 0.20.

The areal extent of peatlands has been rather subjectively determined, with boundaries between peatland types often set arbitrarily. Cultural activities can alter the areal coverage of peatlands faster than land use maps can be updated with

non-satellite remote sensing techniques. The criteria for establishing peatland classes and for assigning map boundaries are seldom stated precisely. Often vegetation classes are first established and only then are the criteria to define them selected. There is a danger in producing a single map from a single Landsat scene because of its inadequacies for identifying and discriminating land use, numberous wetland categories and non-wetland terrain. Since the various peat forming plant associations have almost unique spectral signatures at different times during the growing season, it stands to reason that no single scene is sufficient for inter-vegetation community differentiation.

Only one field trip was carried out during the Spring of 1984 to verify the treed bog, shrub treed fen and graminoid rich fen categories. In addition, information was obtained from 14 sampling sites analysed for surface vegetation and mean depth of peat (Zoltai and Johnson, unpublished)(Table 2). These sites encompassed the following wetland classes (number of sites): Raised bog (1), Bog (1), Fen window bog (2), String fen (4), Shrub fen (2), Ribbed fen (1), Patterned fen (1), Marsh (1).

TABLE 2: SAMPLE PLOTS IN WETLANDS, The Pas Mapsheet (63F)(Zoltai and Johnson unpublished).

Sample Plot#	Location	Wetland Type	Depth of Peat
1	53 46′ & 100 28′	Shrub fen	92 cm
2	53 50′ & 100 48′	Shrub fen	320 cm
3	53 24′ & 101 18′	Fen window bog	75 cm
4	53 26′ & 101 19′	Raised bog	120 cm
5	53 26′ & 101 19′	Ribbed (string) fen	135 cm
6	53 55′ & 101 13′	Bog	143 cm
7	53 20′ & 100 05′	String fen	217 cm
8	53 12′ & 100 38′	Fen window bog	196 cm
9	53 41′ & 101 50′	Marsh	60 cm
10	53 37′ & 101 41′	Treed fen	164 cm
11	53 14′ & 101 04′	Patterned fen	278 cm
12	53 53′ & 101 14′	String fen	118 cm
13	53 27′ & 101 32′	String fen	354 cm
14	53 16′ & 101 14′	String fen	302 cm

The number of pixels successfully classified gave an index of accuracy (Table 1), thus allowing the treed bog theme to represent the bog gradient of variants and the shrub fen and graminoid fen to be two subdivisions of the fen class. Non-discrete spectra for some of the themes (e.g. Fen) resulted in overlap of some categories. Even where the peatland spectra were discrete, reduced accuracy arose from mixing effects. This was probably where two spectrally discrete peatland types in

adjacent areas fell within the same view of the scanner.

The full interactive capability of the ARIES II image analysis system can be used for a temporal classification procedure. While some results are available for a number of different multi-temporal classification schemes, Landgrebe, (1981) emphasized that a significant amount of further work is necessary to resolve the technical and interpretative problems in this area.

For peatlands, further work is still needed to determine which method will relate non-destructive ground truth indices to remotely sensed satellite data. Relationships must be established between each peatland class and attempts to extend correlations from one type of peatland to another.

Two major difficulties were experienced in this study: a) The spectral similarity that occurred when two or more types of peatland vegetation were within a given picture element, thus decreasing the probability of correct classification; b) A problem occurs when signature files developed for one area are used to classify a different area, thus the probability of correct classification also decreases.

Not much time was available for trying to get a higher rate of accuracy.

6.0 CONCLUSIONS

This study has demonstrated that a relatively simple image processing technique produced about 75% of the information required to map the peat and non-peat categories at the 1:250,000 scale.

The analysis of satellite imagery makes large-scale measurements possible, but its value is greatly increased when combined with other data, and when a time series of scene data are available.

Satellite remote sensing of peatland vegetation, when combined with manual and machine interpretation of data, provides a valid estimate of areal extent.

7.0 RECOMMENDATION

On the basis of this project the following recommendation should be considered:

a) That further work be conducted in Southeastern Manitoba where extensive ground reference data is available and could be used to refine the peatland classes through the supervised classification process.

b) If the desired results are not considered satisfactory, use a multi- temporal classification process to define peatland classes.

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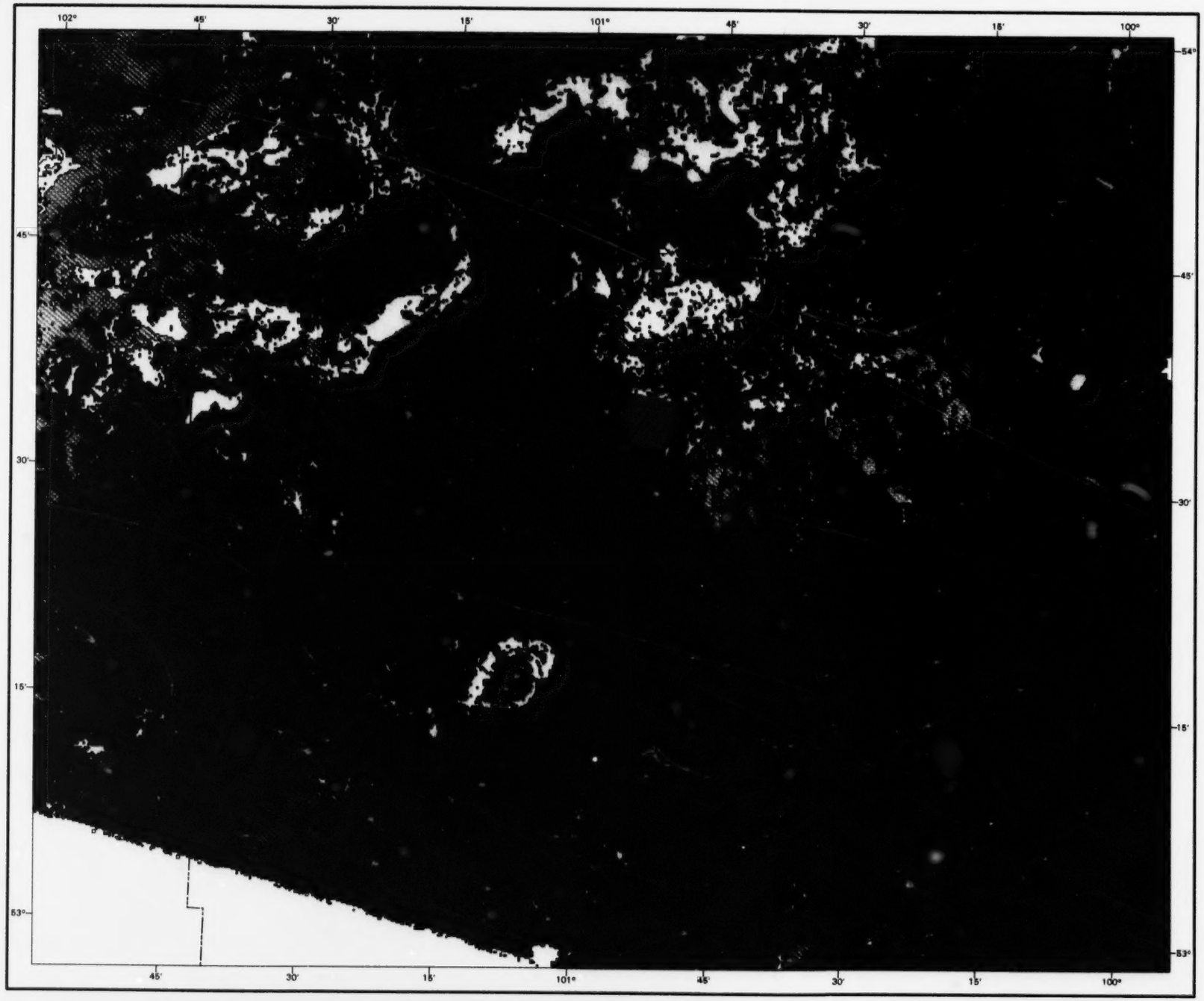
A P P E N D I X

Thematic Map for Peatland Project


102°
45'
30'
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100°
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100°
53°
PATTERN FEN
MARSH
PATTERN FEN
TREED BOG
MIXEDWOODS
CONIFEROUS
DECIDUOUS
CONIFEROUS
PEATLAND INVENTORY OF MANITOBA: I THE PAS
PRODUCED AT MANITOBA REMOTE SENSING CENTRE
N.T.S. 63F THE PAS
Kilometres 0 5 10 15 Kilometres
MULTICLASSIFIED
UNCLASSIFIED
MARSH
WATER
CULTURAL
AGRICULTURE
DELTA MARSH
CULTURAL
G 1007 001